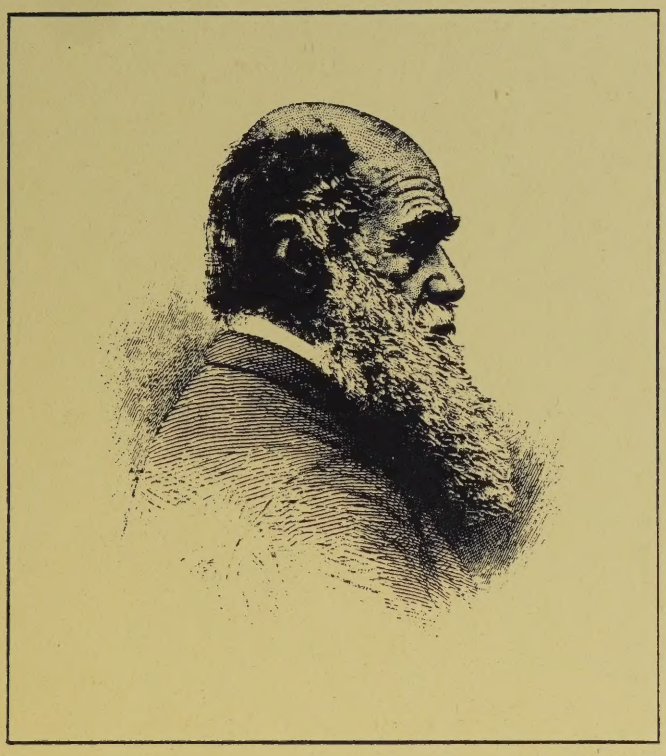


Charles Darwin

a centenary exhibition

Thomas Fisher Rare Book Library
May-June 1982

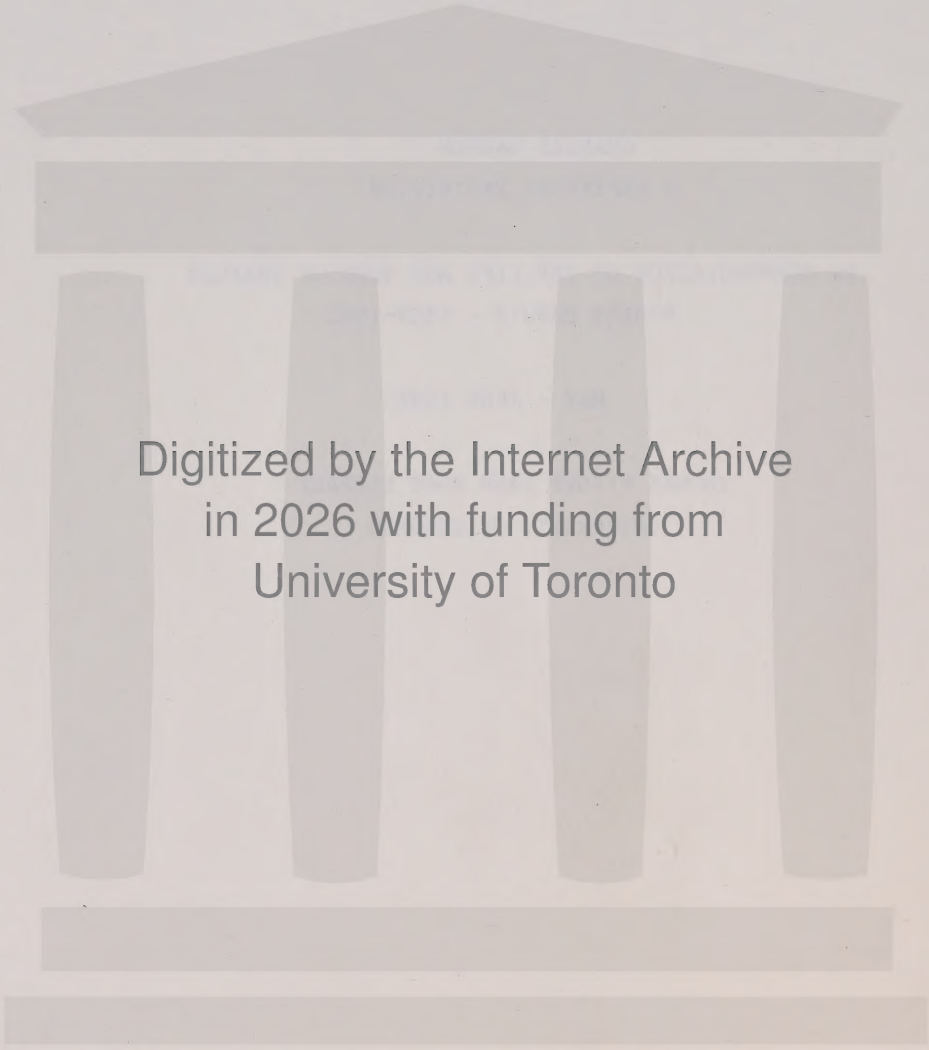
CHARLES DARWIN

A CENTENARY EXHIBITION

IN COMMEMORATION OF THE LIFE AND WORK OF CHARLES ROBERT DARWIN - 1809-1882

MAY - JUNE 1982

THOMAS FISHER RARE BOOK LIBRARY
UNIVERSITY OF TORONTO


Digitized by the Internet Archive
in 2026 with funding from
University of Toronto

https://archive.org/details/charlesdarwincen00land

INTRODUCTION

One hundred years ago, on April 19th, 1882, Charles Darwin died quietly at Down House in Kent where he had lived in semi-seclusion since 1842. His large and closely knit family wished to have him buried in the village of Downe but a group of twenty Members of Parliament, headed by Sir John Lubbock, wrote to the Dean of Westminster on April 21st: "We hope you will not think we are taking a liberty if we venture to suggest that it would be acceptable to a very large number of our countrymen of all classes and opinions that our illustrious countryman Mr. Darwin should be buried in Westminster Abbey." The Dean, G.G. Bradley, cordially acquiesced and Darwin's body was carried from Downe to London in a hearse drawn by four black horses. The funeral was conducted on April 26th with old and intimate friends; Hooker, Huxley, Wallace and Lubbock were joined as pall bearers by dignitaries such as J.R. Lowell, the American Ambassador, the Duke of Devonshire, Chancellor of Cambridge, and William Spottiswoode, the President of the Royal Society. The Queen was represented by Earl Spencer, President of the Council. An anthem was specially composed by Sir Frederick Bridge, based on the text of Proverbs "Happy is the man that findeth wisdom, and the man that getteth understanding".

Darwin is the only naturalist buried in Westminster Abbey. His discoveries and the effects of his work have been compared with those of Copernicus, Galileo and Newton and the centenary of his death provides an opportunity to consider what were the real accomplishments of a long lifetime of dedicated observation and thought. It is, perhaps, particularly appropriate to determine exactly what Darwin thought and wrote, as the debate between the so-called Creationists and Evolutionists continues to this day and the many misperçep-

tions concerning the theory of natural selection have been given a contemporary currency.

Darwin was born on February 12th, 1809 (the same day as Abraham Lincoln) at The Mount, Shrewsbury. His father, Robert Darwin, was the most successful medical practitioner of the area; a large, forceful, intelligent man described by his son as having more highly developed powers of observation and sympathy than any man he had known. Dr. Darwin, treated by his family with great respect and not a little awe, was also a sagacious man of business, increasing his fortune to the extent that his family, including Charles, were comparatively wealthy for the whole of their lives. A careful management of money was one of the traits adopted by his son. Charles Darwin's grandfather was the famous physician and scientist, Erasmus Darwin, whose book Zoonomia (1794) discussed the mutability of of species. This work was read by Charles but did not, according to him, have any influence on the development of his theories. Erasmus Darwin died in 1802. Charles Darwin's mother, Susannah Wedgwood, died when he was seven years old, but the close connections between the two families were maintained. Charles eventually married Emma Wedgwood, his first cousin, after spending much of his youth under the direct influence of Josiah Wedgwood, the head of the famous firm of potters.

Darwin's boyhood was happy and conventional. He attended Shrewsbury School under the Headmastership of Samuel Butler and became a keen hunter of birds, but did not display many scholarly inclinations. In 1825 his father sent him to study medicine at Edinburgh University, where his only brother, Erasmus, was already in attendance. This venture proved unsuccessful and in 1827 Darwin entered Christ's College, Cambridge, to prepare himself for a career in the Church. He graduated in 1831 without much sense of a theological vocation but with a keen amateur interest in natural history, particularly the collecting of beetles. At Cambridge Darwin had been much influenced by the Rev. John Stevens Henslow, a

prominent naturalist, and Henslow determined the course of his career by recommending him for the post of naturalist on the Beagle, a surveying ship commanded by Captain Robert Fitzroy, about to depart on a voyage to South America. After obtaining his father's permission, through the intervention of his uncle, Darwin embarked upon the great adventure of his life on Dec. 27th 1831. Darwin sailed as Fitzroy's guest and the Beagle remained his floating home for the whole five years of the voyage. However he spent as much time as he could on shore in South America, collecting specimens of rocks, flora and fauna. He took with him the newly published first volume of Sir Charles Lyell's Principles of Geology, and the influence of its clearly expressed principles of uniformitarianism was of great importance in the development of his theories.

Darwin returned to England with the Beagle in 1836, a published author with the beginnings of a reputation as a naturalist. He immediately set about arranging his collections of specimens and editing the geological and biological results of the voyage, as well as preparing his Journal for publication. In 1839 he married Emma Wedgwood, was elected a Fellow of the Royal Society, and plunged into the busy and exciting affairs of London scientific society. At about this time he began to develop the symptoms of ill-health that were to plague him for the rest of his life, the causes of which remain a mystery. In 1842 the Darwins moved to the seclusion of Downe where they raised a large family and where Charles continued his researches on material from the voyage, supplemented by local observations and collections sent to him from far-flung correspondents.

In October 1838 Darwin happened to read the sixth edition of Thomas Malthus's Essay on the Principle of Population (1826) and, as he recorded in his autobiography, it provided him with "a theory by which to work". Malthus's great work had been first published in 1798 but had undergone extensive revisions in its later editions. The struggle for existence in human society, described by

Malthus, Darwin applied to the plant and animal worlds, and it immediately became clear to him that his questions concerning the mechanism of selection could be solved by a theory of "natural selection", whereby favourable variations would tend to be preserved and unfavourable ones destroyed, resulting in the formation of new species. Darwin had opened his first note-book on Transmutation in July 1837 and had already accumulated a great deal of evidence.

From 1846 to 1854 Darwin worked on the classification of barnacles, both living and fossil varieties, and the results of what he described as a "little zoology" remain the standard reference sources in the field. As early as 1837 he had begun to compile the Notebooks on the Transmutation of Species and in 1856 he began to write a "large work on species". This was dramatically interrupted on June 18th 1858 by the famous communication from Alfred Russell Wallace, containing a virtually perfect statement of Darwin's own theory of natural selection. After some agonized consultation with his friends, Darwin decided to submit a joint paper to the Linnean Society, consisting of Wallace's paper, an extract from his own work on species, and an abstract of a letter he had sent to Asa Gray in 1857. These were submitted by Hooker and Lyell and read on July 1st 1858. Darwin then hurriedly began to prepare for publication his full statement on natural selection and Origin of Species appeared on Nov. 24th 1859, arousing, as Darwin knew it would, a fierce controversy. The book and the theory were attacked and Darwin's supporters, in particular T.H. Huxley, ranged themselves in defence. Darwin, in the main, kept himself personally out of the fray although maintaining a close interest and providing encouragement and support. He continued to revise Origin through six editions and to work on the series of some ten works which in a sense provide the detailed evidence for his theory. From 1862 to 1881 the books which constitute the bulk of his published work, drawn from his extensive notes and a set of new observations and experiments, occupied fully the time Darwin was able to devote to research and writing, in the midst of his continuing illness and the

concerns of his family.

Darwin lived to see his theories generally accepted by scientists and a knowledgeable public, and to receive the accolades of his peers around the world. His own typically modest assessment of his life's work is given in his Autobiography: "Therefore, my success as a man of science, whatever this may have amounted to, has been determined, as far as I can judge, by complex and diversified mental qualities and conditions. Of these the most important have been - the love of science - unbounded patience in long reflecting over any subject - industry in observing and collecting facts - and a fair share of invention as well as common sense. With such moderate abilities as I possess, it is truly surprising that thus I should have influenced to a considerable extent the beliefs of scientific men on some important points."

The collection from which the books in this exhibition have been drawn is based on that formed by Richard B. Freeman, Darwin's bibliographer. It came to the University of Toronto in 1968 and has been consistently expanded since then. The Darwin Collection at the Fisher Library is comprehensive and attempts to include all the editions, impressions, issues and states of all Darwin's works, in English and in other languages. There is also a large collection of the works of his predecessors, contemporaries and all the later works based on his theories. The exhibition is arranged in the chronological order of Darwin's publications. Supplementing the main exhibition are two cases of pre-Darwinian evolutionary works and two cases of a few of the books of the post-Darwinians. These cases are located in the East and West Reading Rooms of the Fisher Library and notes on the works exhibited are included as a supplement to this catalogue.

Through the great generosity of the Linderman Library at Lehigh University and its Director, Berry G. Richards, we are able to include in this exhibition some unique items from the Robert B. Honeyman collection of Darwin. One of two

surviving sets of proofs of Origin of Species, designated "second revise" is corrected throughout in Darwin's hand and each gathering is dated and initialed by him. There is also a leaf of the original holograph manuscript of Origin. The proof copy of Fertilisation of Orchids is labelled "first proof April 19/62" and the Variation of Animals and Plants is called "1st revise, Mar. 16/67". A most evocative letter, dated April 20, 1882, from Francis Galton, Darwin's cousin and a distinguished scientist, to Lord Aberdare, the President of the Royal Geographical Society, announces Darwin's death and canvasses support to have him buried in Westminster Abbey.

Richard Landon
Philip Oldfield
April 25, 1982

CASE I

The Voyage of the Beagle

The first published result of the Beagle voyage appeared at Cambridge, without Darwin's knowledge, while he was still on the Beagle. It is generally known as Letters on Geology and consists of extracts from ten letters sent by Darwin to Henslow, his mentor, during the course of the voyage. It was issued as a privately printed pamphlet to members of the Cambridge Philosophical Society in December 1835 in an obviously limited edition and has consequently become quite rare. Darwin's earliest knowledge of it was contained in a letter from his sister received by him at the Cape of Good Hope on June 1st 1836, and in his reply he expressed his horror that "what has been written without care or accuracy" should have been printed. Despite this reservation the Letters on Geology did introduce his name and some of his important observations to a number of influential people, and Darwin returned to England in the fall of 1836 with something of a reputation as a geologist. Although this pamphlet is often referred to as Darwin's first published work, he actually appeared in print in 1829, in J.F. Stephens' Illustrations of British Entomology, about thirty of his records of beetles having been included.

Darwin's first major work and the first book to bear his name was the Journal of Researches, or, as it has become commonly known, The Voyage of the Beagle, his personal record of his journey around the world. It has correctly assumed its place as a key book for those who would attempt to understand the process by which Darwin gathered evidence and developed his concept of evolution. The Journal of Researches has also come to be appreciated as one of the most fascinating of nineteenth-century travel books, and the most widely read of Darwin's works. It was first issued as the third volume of the Narrative of the

Surveying Voyages of His Majesty's Ships Adventure and Beagle, Between the Years 1826 and 1836; Describing their Examination of the Southern Shores of South America, and the Beagle's Circumnavigation of the Globe (London, Colburn, 1839). The manuscript was completed in June 1837 and the whole volume was in print by 1838, but had to wait for the other volumes to be completed before it could be issued. The second issue also appeared in 1839, the third volume of the set becoming a separate monograph. The preliminary pages i to vi were cancelled and replaced with a title page which read Journal of Researches into the Geology and Natural History of the Various Countries Visited by H.M.S. Beagle, Under the Command of Captain Fitzroy, R.N. from 1832 to 1836. The sheets of the text were from the first issue. It has been generally thought that because public demand for Darwin's volume far exceeded that for the rest of the first issue set, the seco issue was put on the market later in 1839. A third issue, with new and conjugate title and half title leaves, dated 1840, but otherwise similar to the second issue was also published. The second edition, with the title altered to read Journal of Researches into the Natural History and Geology of the Various Countries ... was published by John Murray in 1845. It has been claimed that the change in position of the words 'geology' and 'natural history' points out the change in Darwin's primary interests as he studied the results of the Beagle expedition and thus can be seen as an integral part of his development of the theory of evolution. The second edition was issued as three parts of Murray's Colonial and Home Library series (nos. XXII-XXIV) and was extensively revised, the number of words being reduced from 224,000 to 213,000. The same year Murray reissued the book in one volume, as volume XII of the Colonial and Home Library series.

The edition published by Murray in 1860 (10th thousand) constitutes the final text as Darwin left it and the book has remained in print ever since, close to one hundred editions, some of them extensively illustrated, having been issued. Darwin's manuscript Journal, from which the Journal of Researches was

prepared, was edited in 1934 by Lady Barlow and has recently appeared in a full facsimile.

CASE II

Geology, Zoology and Barnacles

The scientific results of the Beagle voyage began to appear in 1838 when the first of five parts (in nineteen numbers) of the splendidly illustrated Zoology of the Voyage of H.M.S. Beagle, edited by Darwin, was published. The authors of the five parts were Richard Owen (Fossil Mammalia), George Robert Waterhouse (Mammalia), John Gould (Birds), Leonard Jenyns (Fish), and Thomas Bell (Reptiles). There were many delays in publication and the final part did not appear until 1843. Darwin's own contributions to the work consisted of a geological introduction to Part I and a geographical introduction to Part II, as well as notices of habits and ranges for the Mammalia and Birds and many notes.

Geological Observations on Coral Reefs, Volcanic Islands, and on South America, Being the Geology of the Voyage of the Beagle ... (London, Smith, Elder, 1851), the geological results of the Beagle voyage, was originally issued in three parts over a period of five years (The Structure and Distribution of Coral Reefs, 1842; Geological Observations on the Volcanic Islands, 1844; Geological Observations on South America, 1846). That the three parts were intended to form one complete work is indicated by their title pages and the 1851 edition consists of the unsold sheets of the original parts with the title pages and half titles discarded and a new, general title page substituted. In 1874 Smith, Elder reissued the Coral Reefs volume by itself as the 'second edition, revised'. It had been almost completely rewritten by Darwin to take account of the work on

coral reefs by James Dwight Dana and others, and to answer some of their criticisms. Darwin had proposed a theory of 'subsidence' to account for the structure of the coral reefs, particularly the great depth of water through which they rose from the ocean floor to the surface. Although questioned by geologists of his time, this theory has proven to be substantially correct. The other tw parts of the general work (Volcanic Islands and South America) were republished in 1876 as a single volume. Although called a 'second edition', the text was unaltered, a few references in the preface being the only additions. There have been few reprints of these works, although the general importance of Darwin's geological work during the Beagle voyage has long been appreciated, especially his development of techniques of observation later focussed on subjects of natural history.

Darwin became interested in barnacles when he discovered on the coast of Chile a peculiar species of burrowing barnacle for which he had to create a special sub-order. After the Geological Observations on South America was published in 1846 he planned to proceed with what he described as a 'little zoology' and chose the cirripedes. Eventually he had some ten thousand specimens from all over the world to study and his direct involvement with both the living and fossil forms of the sub-class lasted eight years. In 1852 he recorded in a letter that he had come to "hate a barnacle as no man ever did before". The two volumes on the living cirripedes were published by the Ray Society in 1851 and 1854 (numbers 21 and 25 of the Society's publications) and although neither of the volumes gives any specific indication that it is part of the same work as the other, the volumes are collectively called A Monograph on the Sub-Class Cirripedia. In the same years (1851 and 1854) the Palaeontographical Society issued the results of Darwin's study of the fossil cirripedes of Great Britain. Volume one was titled A Monograph on the Fossil Lepadidae and volume two was called A Monograph on the Fossil Balanidae and Verrucidae. Again the title pages do not link the two

works, but the preface to volume two states that it completes the work. These four volumes constitute Darwin's only contribution to formal taxonomy. Although some of his friends regretted what they considered his waste of time on minutiae, Darwin himself saw the work as a partial substitute for the formal scientific training in natural history which he lacked.

In 1849 Sir John F.W. Herschel edited A Manual of Scientific Enquiry, Prepared for the Use of Her Majesty's Navy and Adapted for Travellers in General. Darwin contributed the article on geology, which occupies pages 156 to 195. It consisted of suggestions for the aspiring geologist concerning what to look for and how to record and preserve what he noticed. In the same year, Darwin's article was reprinted as a repaginated pamphlet in which corrections necessitated by compositors' errors were made. The errors, however, exist only in some copies of the Manual, which thus has two 'states'. The repaginated pamphlet is titled Geology. The Manual of Scientific Enquiry went into a second edition in 1851, in which Darwin's contribution, in the form of the corrected text, occupies pages 166 to 204. Its third, fourth and fifth editions were published in 1859, 1871 and 1886, with no further corrections to Darwin's article.

In 1851 Thomas Henry Huxley, aged twenty-six, was an applicant for the Chair of Natural History at the University of Toronto and Darwin contributed a testimonial of some five lines. Although Huxley's testimonials were fulsome in their praise the post was given to William Hincks, the brother of Sir Francis Hincks, Prime Minister of Upper Canada.

CASES III-IV

The Origin of Species

On June 18, 1858 Darwin's work on the 'large book', which was to include the results of his research up to that point, was interrupted by the famous communication from Alfred Russell Wallace. It contained a virtually exact statement of Darwin's own theory of evolution by natural selection. Darwin submitted Wallace's paper to Lyell and Hooker and asked for their advice concerning how he should handle a potentially awkward situation. In what must be one of the most notable cases of cooperation rather than competition in announcing scientific discoveries it was decided that Darwin should assemble an outline of his own theory and the two should be submitted jointly to the Linnean Society by Lyell and Hooker. Thus Darwin's first published announcement of the theory of evolution appeared, as part of the joint paper, in volume III, number 9, pages 45-62 of the Journal of the Proceedings of the Linnean Society of London, Zoology. Darwin's contribution consisted of two short pieces: Extract From an Unpublished Work on Species ... and Abstract of a Letter ... to Prof. Asa Gray ... dated Down, September 5th, 1857.

The Darwin/Wallace paper had been read to the Linnean Society on the evening of July 1st, 1858 and there then developed considerable pressure on Darwin to write and publish a complete statement of his theory of natural selection as quickly as possible. Accordingly, he began work on the book, which he still thought of as an "abstract", on July 20th 1858. It soon developed into a substantial work which John Murray accepted for publication in April 1859. By June 14th Darwin was reading proofs, in which he made extensive corrections, a process he was to continue through all six editions of the book. The "second revises", from the Honeyman Collection, are dated and initialed from July 16th to September 30th, with the final date of October 8th appearing on the title page,

although Darwin had dated the book October 1st on the half title leaf. One of the dramatic manuscript alterations occurs on the title page where the word "On" is added to the title of the book.

On the Origin of Species by Means of Natural Selection; or, The Preservation of Favoured Races in the Struggle for Life was published November 24, 1859. Contemporary accounts gave rise to the oft-repeated statement that an eager public bought up the whole first issue of 1250 copies on the first day, and, although this claim is not strictly true, the book was very popular for a difficult scientific work. It was widely read and hotly debated; for the theory of natural selection it proposed could be universally applied to man as well as to plants and animals. Humans were thus placed in a relationship to all other living things that shook traditional scientific and theological beliefs to their very foundations.

The type from which the first edition was printed was not completely reset until the sixth edition (1872). The printers considered each edition as a working revise and only reset as much as was necessary to incorporate the revisions; thus the work, for the first thirteen years of its existence, was in a state of almost continual revision. The physical extent of the changes made between editions is well illustrated by the example of the fifth edition. Between the fourth edition (1866) and the fifth (1869) 178 sentences were dropped, 1770 sentences were rewritten and 227 sentences were added. Changes were not confined only to the edition revisions. Darwin was able to make small changes, usually altering only single words and punctuation, between each issue or 'thousand'. The eleven separate issues, from the first to the eighteenth thousand, thus all contain textual alterations. The third edition (1861) contained a table of 'Additions and corrections to the second and third editions' and 'An historical sketch of the recent progress of opinion on the origin of species'. There appears in the sixth edition (1872) a 'Glossary of the principal scientific terms used in the present volume', compiled by W.S. Dallas. The sixth edition of 1872 was considered for many years to

be the definitive text; however, the 1876 printing, called the 'eighteenth thousand', has slight textual changes, which establish it as the final text as Darwin left it. The word 'evolution' does not appear in Origin until the sixth edition. Origin has been translated into at least twenty-nine languages, the first being that of H.G. Bronn into German (1860). The first American edition was published by Appleton in New York in 1860 and there are four Appleton printings of that year, the fourth of which contains some notes by Darwin which are not included in the second English edition of the same year.

The effects of Darwin's basic concept of natural selection continue to be felt and it has directly influenced biological research. Its total effect, however is perhaps more pervasive because "Darwinian" theories have been applied to almost every sphere of human activity, from linguistics to sociology.

CASE V

Plants, Insects, Animals and Variation

Because Darwin considered The Origin of Species to be an 'abstract' of a projected work, he had, after its publication, an immense amount of surplus material which he had not been able to include. This supporting evidence for his theory, to which he continued to add, began to be published in 1862, the first book being called On the Various Contrivances by which British and Foreign Orchids are Fertilised by Insects, and on the Good Effects of Intercrossing. It was concerned with the relationships between the sexual structures of orchids and the insects that fertilize them, and Darwin was able to demonstrate that natural selection had determined their evolution. He wrote to John Murray on September 24th, 1861, "I think this little volume will do good to the 'Origin',

as it will show that I have worked hard at details". The proofs, from the Honeyman Collection, are dated from March 8th to April 19th, 1862 and the first edition appeared on May 15th, a demonstration of how quickly a substantial and complex book could be published in mid-nineteenth century London. The second edition, published in 1877, altered the title to read The Various Contrivances by which Orchids are Fertilised by Insects and all subsequent reprints are from the stereo plates of this edition. Although recognized by botanists to be of considerable importance, this work was not a great commercial success, selling only about 6,000 copies by 1900.

On the Movements and Habits of Climbing Plants, the second book of specialized evidence of evolution by natural selection, was first published in volume IX of the Journal of the Linnean Society of London (1865). It occupies pages 1 to 118 of numbers 33 and 34 of the Journal and existed only in this form, and that of an offprint with its own title page, until 1875 when John Murray issued a second edition, extensively revised and enlarged. The third thousand of 1882 constitutes the final text, an appendix to the preface and an errata note having been added. It was reprinted by Murray up to 1937, the last Darwin book to be kept in print by this publisher. Darwin approached the subject from his usual 'evolutionary' point of view. Rather than just elucidate the physiological peculiarities of climbing plants he wished to demonstrate the common descent of plants with the properties of climbing.

In 1860 Darwin began to write his longest single work, The Variation of Animals and Plants Under Domestication, the only section of what he referred to as his "big book" to be published in his lifetime. It was not until March 16th, 1867, as indicated by the proof copy from the Honeyman Collection, that he was able to complete it and publication was held up, for the index to be completed, until early 1868. There are two issues of the first edition, the first published on January 30 and the second in February, which contain many textual

differences although their title pages are identical. Strangely, the Russian translation partly precedes the first English edition. Darwin sent corrected proofs to the translator, V.O. Kovalevskii, who managed to issue the first four parts during 1867. The second edition of 1875 was again revised extensively and remained the standard text, subsequent reprints having been taken from the stereos of it. Chapter XXVII contained the first explication of Darwin's hypothesis of pangenesis, an attempt to bring into coherent focus many of the apparently diverse phenomena he had noticed regarding heredity, including acquired characters, the effects of use and disuse, variation, graft-hybrids, hybridization, reversion to ancestral type and atavism, regeneration, reproduction and embryonic development. His use of hypotheses, already attacked by critics of Origin, he justified by quoting William Whewell's statement that 'hypotheses may often be of service to science, when they involve a certain portion of incompleteness, and even of error'. Darwin regarded this work as an installment of the evidence and a reference for the conclusions he had reached in Origin, which he had promised the readers of that book. His hypothesis of pangenesis was, of course, wrong and it was not until 1900, when the discoveries of Gregor Mendel, which had been totally ignored for thirty-five years, were "re-discovered" by de Vries and others, that many of Darwin's problems could be solved using the principles of Mendelian genetics.

CASE VI

Man, Emotions and More Plants

Although another volume of accumulated evidence was originally intended to follow Variation of Animals and Plants, Darwin became so tired of the subject while waiting for it to be published that he turned, for relaxation, to the composition of The Descent of Man, and Selection in Relation to Sex. As early as 1837 he had recorded in his Notebooks on Transmutation of Species, "Man in his arrogance thinks himself a great work worthy the interposition of a deity. More humble and I believe truer to consider him created from animals". In Origin he had skirted the obvious logical extension of his theory into the human realm by merely mentioning that, through his theories, "light will be thrown on the origin of man and his history". The first edition of Descent of Man was published February 24, 1871 in two volumes by John Murray. Again there are two issues which appear to be exactly the same externally, but which contain important textual differences. The first American edition (New York, Appleton, 1871) is based on the first issue of the English edition, although it corrects some of the minor literal errors. Later in the same year two further issues, the seventh and eighth thousands, each containing small textual changes, were published. The second edition (tenth thousand) appeared in 1874 in one volume, extensively revised, and containing a note by T.H. Huxley on the brains of man and apes. The definitive text is the twelfth thousand of 1877, and reprints of it reached the thirty-fifth thousand by 1899. Almost three quarters of this work is taken up with sexual selection, mentioned by Darwin in Origin as being another agency through which evolution could be explained. The development of special structures which relate to the mating of animals, such as the peacock's train and the deer's antlers, are explained by the hypothesis of sexual selection, and Darwin also deals with sexual

selection in man. The examples he cites, ranging through the whole animal kingdom from molluscs to man, account for the length of this work. The simple conclusions of the book, which did not arouse nearly as much public controversy as expected, was that "man and all other vertebrate animals have been constructed on the same general model". The probable reason for its general acceptance was that most of the energy of the religious opponents of the theory of evolution had been expended during their attacks on Origin.

In The Expression of the Emotions in Man and Animals Darwin moved into an area which today would be considered essentially psychological. It is, however, intimately related to his evolutionary studies, its impetus being a rejection of the concept, maintained by Sir Charles Bell, that the facial muscles of expression in man were a special endowment. Darwin had for many years closely observed both his children and his pets and made notes on the different ways emotions were expressed by them. He was thus able to formulate three principles underlying the expression of emotions. First, certain movements and actions indicate a particular state of mind and will be reproduced when this state of mind is induced even though they are of no use. An example of this is a man snarling, although he no longer has large canine teeth with which to follow through the threat. The antithesis of this principle constitutes the second principle. When the state of mind is reversed the movements or actions will also be reversed. The third principle states that certain reflex actions depend on the structure of the nervous system. The first edition was published on November 26, 1872 by Murray in an edition of 7,000 copies, very large for a Darwin first. A second edition was not needed until 1890, when it was edited by Darwin's son Francis, incorporating notes accumulated by Darwin between 1872 and his death in 1882. The first American edition was published by Appleton in 1873 and the work was translated into the major European languages.

Darwin next turned again to the study of plants. He had previously noticed with surprise the large number of insects captured by the common sundew in Sussex and so began to experiment with these plants. He tested the plants' reactions to such diverse substances as raw meat and poison from a live adder. He discovered that the impulse which causes the tentacles to bend is transmitted through the cellular tissue of the leaf, and calculated that the plants were seventy-eight times more sensitive than the swing balances of his time, being able to distinguish a piece of human hair weighing 0,0008 milligrams. In 1875 he published the results of these experiments in Insectivorous Plants, relating them to his evolutionary works through a study of the adaptations of the plants to impoverished conditions. The second and third thousands were also published in 1875, the second adding an errata slip and the third correcting these errata, but adding a slip with six more. Francis Darwin revised the book and published the second edition in 1888, which also included some small corrections by Darwin himself.

The Effects of Cross and Self Fertilisation in the Vegetable Kingdom continued Darwin's studies in the field of botany. He conducted experiments on fifty-seven species of plants over a period of twelve years and concluded that cross pollination produces more numerous, larger, more vigorous plants than self pollination. His results were published in 1876. Although 1500 copies were sold before the end of the year, the work was too specialized and technical to attract a wide audience. The second edition appeared in 1878 with a few revisions and was reprinted four times.

A number of Darwin's observations and experiments on flowers of different style lengths were published in the Journal of the Linnean Society of London and other periodicals. In 1877 he brought together, with extensions and revisions, the whole series and published it as The Different Forms of Flowers on Plants of the Same Species. As a work with wide appeal it suffered from the same defects

of complexity and technicality as The Effects of Cross and Self Fertilisation. A second edition, to which Darwin added a new preface listing recent studies on the same subject, was published in 1880 and Francis Darwin added another 'survey of recent literature' to the third thousand of 1884.

CASE VII

Earthworms, Mould and More Plants

The Power of Movement in Plants, published in 1880, was the result of five years experiments carried out by Darwin with the assistance of his son Francis. It was an extension of his work on climbing plants and attempted to show that the mechanisms used by the twining plants were the same as those for flowering plants in general. This book seems to have been the least popular of Darwin's works, the third thousand of 1882 being the last English edition recorded by Freeman, although Appleton continued to issue it in the United States up to 1900.

For his last major work Darwin chose a subject which had interested him since the time of the Beagle voyage, and in 1881 Murray published The Formation of Vegetable Mould, Through the Action of Worms, with Observations on their Habits. The 'worm stone' at Down House is now a well known tourist attraction and it is recognized that Darwin's study of the part played by worms in the aeration of soil and the formation of mould essential to plant life constitutes a pioneer work in ecology. There were six separate printings of the book in 1881 and it achieved its thirteenth thousand in 1904. The changes made between thousands, although small, are of some textual significance, the corrections after the seventh thousand of 1882 having been made by Francis Darwin.

In 1879 Ernst Krause published a short biography of Erasmus Darwin in Kosmos.

The same year W.S. Dallas translated it and Murray published it as a separate work with a 'preliminary notice' by Darwin, which turned out to be longer than Krause's original work. A second edition of 1887, edited by Francis Darwin, credited Darwin with more of the work and added a footnote stating that the original German text had been slightly altered. The omission of this footnote from the first English edition had provided Samuel Butler with the impetus for an acrimonious and sustained attack to which Darwin never replied. The quarrel was not reconciled until 1911 when Henry Festing Jones issued a pamphlet called Charles Darwin and Samuel Butler: A Step Towards Reconciliation, with the approval of Francis Darwin.

CASE VIII

Westminster Abbey and After

In 1882 George J. Romanes published a work called Animal Intelligence which contained long quotations from Origin and Descent of Man. It also had a number of extracts from Darwin's notes on behaviour, which were here published for the first time. The book was in the press at the time of Darwin's death. Nine editions, which are really reprints, were published up to 1910. Romane's Mental Evolution in Animals, published in 1883, contained, as an appendix, what was called a 'posthumous essay on instinct' by Darwin. It was in fact part of Darwin's 'large work' on origin of species, of which Origin had been an abstract.

After Darwin's death in 1882 his son Francis edited a three volume biographical work called The Life and Letters of Charles Darwin, Including an Autobiographical Chapter. It was first published by Murray in 1887 and reached its seventh thousand in 1888. The second edition of 1887 was revised slightly and

an abridged edition in one volume, called Charles Darwin: His Life Told in an Autobiographical Chapter was published in 1892. Francis Darwin and A.C. Seward produced in 1903 More Letters of Charles Darwin, and Henrietta E. Litchfield edited in 1904 a privately printed work called Emma Darwin, Wife of Charles Darwin; a Century of Family Letters. It was actually first published by Murray in 1915. All these works contain a great deal of information both about Darwin's personal life and his work. They assume an especial importance in any discussion of the question of Darwin's very poor health over the largest part of his working career and the effect of his health on his work.

Darwin's 'notebooks' and 'journal' which survived in manuscript, have been published in recent years. They supplement and illuminate many of his principal books and provide records of observations and experiments not used during Darwin's life. The 'journal' appeared in the Bulletin of the British Museum (Natural History), Historical Series (v. 2, p. 1-21) in 1959. In 1960-61 and 1963 the 'notebooks on transmutation of species', edited by Sir Gavin de Beer and the 'ornithological notes', edited by Nora Barlow appeared in the same publication. Previously unpublished manuscripts continue to be edited and published and a Collected Letters is in progress.

Charles Darwin, early in his career, remarked in a letter to John Maurice Herbert that he had "long discovered that geologists never read each others works, and that the only object in writing a book is a proof of earnestness, and that you do not form your opinions without undergoing labour of some kind". From the time he returned from the Beagle voyage until his death Darwin laboured steadily. His total production was twenty books and three pamphlets. He also contributed to eight books and one pamphlet. Since his death, the total number of his works has been augmented with the publication of his letters, notebooks, diaries, and the manuscripts left unfinished by him. A number of his papers were pu

lished by the scientific periodicals of his time and about ninety communications to learned societies were received from him. Almost every one of Darwin's books appeared in more than one edition and almost every edition had textual revisions of great importance. Many of the editions were further subdivided into 'issues' or, as his principal English publisher, John Murray, called them 'thousands', and there were often small changes made between the thousands. Because of this kind of publishing history, a complete collection of Darwin's works, which would seem comparatively small at first glance, becomes quite extensive. When the mass of Darwiniana - the works of the predecessors, contemporary commentaries by supporters and detractors and later works about evolution - are added to the collection it becomes very large indeed. This exhibition displays only a few of the highlights from a large collection, the purpose of which is to provide the curious researcher with as much information as possible on the work of a man who profoundly altered the way we perceive ourselves.

SUPPLEMENT

Notes on Pre-Darwinian Evolutionists and the Works of Darwin's Contemporaries.

For the third edition of Origin of Species (1861) Darwin wrote "An Historical Sketch of the Progress of Opinion on the Origin of Species, Previously to the Publication of the First Edition of this Work". It was composed to satisfy complaints that he had not given proper credit to his predecessors in the general theory of evolution, and in it Darwin gave acknowledgement to those naturalists who had discussed the modification of species, whether he had read and been influenced by their work or not. Paley, Lyell and Malthus had a direct influence on his work although none of them had discussed transmutation and thus did not appear in the "Historical Sketch".

Among the early predecessors of evolutionary theory, Darwin's grandfather, Erasmus Darwin (1731-1802), is conspicuous. Although in the "Historical Sketch" and his autobiography, Charles tended to play down the influence of Erasmus on his own thought, there are clear intimations of an evolutionary view of nature in the elder Darwin's poetry and prose. In his great work, Zoonomia; or, The Laws of Organic Life (1794), Erasmus expressed the belief that in the struggle for existence organisms adapted themselves to their environment through the promptings of such natural desires as lust, hunger and security; the resulting charges were then passed down to succeeding generations in a continuous, progressive process.

While Darwin claimed that his grandfather's principal distinction was in having anticipated the evolutionist theories of the French biologist, Jean-Baptiste de Lamarck (1744-1829), it is Lamarck who is generally regarded as having anticipated him. In his Philosophie zoologique (1809) Lamarck supposed

a tendency in nature to perfection and increased complexity, and conceived of living organisms as forming a hierarchy, the higher orders having a greater specialization of organs than the lower. Like Erasmus Darwin, Lamarck was one of the first to recognize the important relationship that exists between organisms and environment. According to Lamarck, changes in the physical environment pre-determine the needs of the organism and bring about changes in behaviour and habit which by degrees alter the corporeal structure.

Although Lamarckism has been largely discredited today, the importance of Lamarck as a progenitor of the theory of evolution is undeniable and Darwin's tribute in the "Historical Sketch" for his "eminent service of arousing attention to the probability of all change in the organic, as well as in the inorganic world, being the result of law", is well justified.

Among those whose writings may be genuinely regarded as anticipating Darwin's theory of natural selection are William Charles Wells and Patrick Matthew, both of whom are mentioned specifically by Darwin in the "Historical Sketch". Although both men speculated on the question of natural selection, their works remained little known until the publication of Origin. Darwin himself had not heard of either man until the 1860s when his attention was drawn to them.

William Charles Wells (1757-1817) was an American-born physician who practised in England. In 1813 he delivered a paper to the Royal Society on a white woman with patchy brown discolouration of the skin. His discussion of this unusual case is almost a complete anticipation of Darwin's theory of natural selection. The paper was published posthumously in 1818 together with Wells's essay on binocular vision, and his famous Essay on Dew.

Patrick Matthew (1790-1874) was a Scottish agricultural writer about whom very little is known. His statement of the theory of natural selection is contained in the appendix to his book On Naval Timber and Arboriculture, published

in 1831. In another of his works, Emigration Fields; North America, The Cape, Australia and New Zealand, which appeared in 1839, Matthew discusses the various countries to which Great Britain might send its surplus population, and speculates on such ideas as adaptation to environment and the struggle for existence. Early in 1860 Matthew wrote to the Gardener's Chronicle, proclaiming his priority to the theory of natural selection and quoting from Naval Timber. Darwin cheerfully acknowledged Matthew's contribution in the "Historical Sketch" but remarked that he had had difficulty in understanding some passages.

In 1844 a work entitled Vestiges of the Natural History of Creation appeared anonymously. The author of the work, although not officially revealed as such until much later, was Robert Chambers, editor of the Chambers's Journal, and the author of a number of historical, literary and biographical works. Vestiges contained a bold statement of the evolutionary theory, similar to that espoused by Lamarck, based on the natural law of development. It expressed the idea that higher orders arise from lower ones as a result of an inherent proclivity to progressive development. Chambers's work was widely read, four editions appearing in the first seven months, and ten editions in as many years, even though it was generally condemned by competent scientists, especially Sedgwick and Huxley. Darwin was highly critical of the book, particularly as the author advanced no explanation as to how the dubious progression from lower organisms to higher forms was affected. The first edition of Origin dismissed Vestiges contemptuously, though Darwin's tone in the "Historical Sketch" was more conciliatory. Despite its spurious scientific argument, Vestiges had a considerable importance in that the discussion it engendered prepared the scientific and quasi-scientific community for the much more serious discussion of the theory of natural selection.

Darwin was introduced to the works of William Paley (1743-1805), a theologian much influenced by Malthus, while at Cambridge. He was most impressed by

Natural Theology (1802) which contains the fullest and clearest statement of Paley's teleological argument. According to Paley, there was an order in the universe that bore testimony to a Grand Design behind creation. Arguing against the early evolutionary theories of Buffon and Lamarck, Paley claimed that the various structural adaptations of animals to their environment were the conscious results of divine design. He then proceeded to catalogue the anatomical oddities which ensure survival in hostile environments. Even though much of Natural Theology was cribbed from John Ray's Wisdom of God (1691) Darwin admired Paley's orderly and logical reasoning and recorded that it gave him "as much delight as did Euclid". He also remarked that he had not, at the time, troubled himself much about Paley's premises.

Darwin read Thomas Robert Malthus's Essay on the Principle of Population (1798) in 1838 "for amusement", as he recalls in his Autobiography. Malthus's famous essay was based on the theory that population grows in a geometrical ratio, while agricultural production increases only arithmetically; the rapid increase in population thus doomed many to misery and deprivation. Darwin claimed that Malthus's description of the struggle for existence in human society provided him with a key to an understanding of the self-regulating mechanism by which natural selection can operate. By transferring the principle of struggle for existence to the animal and plant kingdoms, Darwin realised that the favourable or "strong" variations emerging from the struggle would tend to be preserved, while unfavourable or "weak" variations would perish; the result being the formation of new species. Coincidentally, Wallace, who arrived at the theory of natural selection independently, was also strongly influenced by Malthus's Essay. They both read the sixth, and much revised, edition of 1826.

One of the books that Darwin took with him on the Beagle voyage was Principles of Geology, the classic work of Charles Lyell (1797-1875), the leading

British geologist of his time. Principles was a great inspiration to Darwin, whose own findings in South America supported Lyell's theory of uniformitarianism, a view that challenged the notion of catastrophism in geology. On Darwin's return from the voyage in 1836, a warm friendship developed between the two men. When Darwin explained the theory of natural selection to Lyell in 1856, Lyell urged Darwin to publish, but Darwin was reluctant to announce his theory publicly before sufficient biological and geological evidence had been gathered to support it. Darwin's hypothesis and Wallace's findings on species persuaded Lyell to accept at least tentatively the possibility of mutability of species. In 1863 The Geological Evidences of the Antiquity of Man appeared - the result of Lyell's examination of the early existence of man in Europe. The wealth of evidence assembled by Lyell indicated that man had descended over an immense period from a common ancestry, and that plants and animals had likewise developed from common parentage. Although accepting Darwin's theory of indefinite modification of specie as a likely explanation of many puzzling biological and geological phenomena, Lyell was not yet ready to declare his own adherence to the theory. Lyell's reluctance to draw the obvious conclusion from his findings in Geological Evidences exasperated Darwin, who was greatly disappointed by Lyell's book. But gradually Lyell came round to Darwin's point of view. By 1868, while preparing the tenth edition of his Principles of Geology, he was finally converted to Darwin's theory and completely reworked his book to conform with Darwin's principles, and to express his wholehearted conviction of the truth of the theory of natural selection.

Darwin became acquainted with Adam Sedgwick (1785-1873) during his years at Cambridge, where Sedgwick was Professor of Geology. Although Darwin did not attend Sedgwick's lectures, he accompanied him on a walking tour of North Wales before his departure on the Beagle voyage. When the journals of the voyage

appeared, Sedgwick predicted that Darwin would have "a great name among the naturalists of Europe". However, his estimation of Darwin changed when he read Origin. A deeply religious man and an ardent creationist, Sedgwick recognized the danger that evolutionary theory posed for natural theology, and condemned Origin as a pernicious book. Despite Darwin's advocacy of an heretical theory and Sedgwick's fierce condemnation of it the relationship between the two men remained cordial throughout their lives.

Richard Owen (1804-1892) earned a deserved reputation as the leading comparative anatomist of his day, yet his personal reputation is tainted by the petty and sometimes dishonest controversies in which he frequently involved himself. In particular, his deprecation of Darwin places him in an unfavourable light. Despite the fact that Owen in his work on homology had articulated views that had clear evolutionary implications, and had, in private correspondence and conversation with Darwin, expressed sympathy with the theory of natural selection, he was nevertheless capable of writing an unfavourable review of Origin in The Edinburgh Review. The anonymous review served the double purpose of allowing Owen to praise himself and to advance his own claim to priority of the theory, and at the same time to criticize Darwin with an abandon he could not otherwise have enjoyed.

Owen also appears to have collaborated with Samuel Wilberforce, Bishop of Oxford, in writing a scathing attack on Darwin in The Quarterly Review, even though he had no sympathy for "Biblical objectors" as he called orthodox theologians. Owen also coached Wilberforce for the Bishop's famous debate with Huxley at the 1860 meeting of the British Association.

Joseph Dalton Hooker (1817-1911), who succeeded his father, William Jackson Hooker, as Director of Kew Gardens, was an intimate friend of Darwin and his botanical knowledge was indispensable to Darwin in developing his theory of natural selection. Hooker was acquainted with Darwin's theory as early as 1844, but for a long time he hesitated to accept it fully. Even in 1853, when his Flora

Novae - Zelandiae appeared, Hooker was still advocating the immutability of species. The obstacles to accepting an evolutionary theory were to Hooker not ideological but scientific, for he found much of Darwin's evidence inconclusive. Between 1853 and 1860 Hooker gradually became convinced of the validity of Darwin's theory, though he preferred to wait until the publication of Origin before openly avowing his conviction. It was in his Flora Tasmaniae (1860) that he proclaimed for the first time his acceptance of the theory of natural selection, adducing abundant botanical evidence to support it, and thus gaining the distinction of being the first person to utilize the theory before it was published. Throughout the remainder of his long and distinguished career Hooker continued to advocate and defend the theory of natural selection.

The co-founder of the theory of natural selection, Alfred Russell Wallace (1823-1913), began his career in natural history, as had Darwin, with a journey to South America. He spent from 1848 to 1852 exploring the Amazon basin, and followed this by an extensive exploration of the East Indies from 1854 to 1862, during which he developed his theory.

Wallace's first published pronouncement on evolution was his paper "On the law which has regulated the introduction of new species" which appeared in Annals and Magazine of Natural History in 1855. But it was in his famous paper "On the tendency of varieties to depart indefinitely from the original types" that his theory of natural selection was fully articulated. Wallace's subsequent writings on evolution include the collection Contributions to the Theory of Natural Selection (1870); Geographical Distribution of Animals (1876), a monumental work laying the foundation of evolutionary zoogeography; and Island Life (1880) which examined the variation, distribution and dispersal of insular flora and fauna. The important Darwinism (1889) summarizes Wallace's mature reflections on thirty years of evolutionary biology, and is the most authoritative statement on the subject in the late nineteenth century.

Although the modest Wallace greatly revered Darwin he disagreed with him over the question of the descent of man. After a conversion to spiritualism in the 1860s, Wallace maintained that man had partially escaped the power of natural selection and could himself influence organic change by selection. Wallace further advocated the belief that man's moral and intellectual nature had been uniquely formed by a divine intelligence and such a conclusion, from evidence that Wallace clearly understood, shocked Darwin.

Wallace's later works, such as The Wonderful Century (1898), Man's Place in the Universe (1903) and Is Mars Habitable? (1908), and his belief in spiritualism, his campaign against vaccination and his advocacy of socialism, have earned him the undeserved reputation of an eccentric. Yet his scientific contributions are unquestionably among the most brilliant and important of the nineteenth century.

Darwin met Thomas Henry Huxley (1825-1895) in 1851, and his first letter to the young naturalist was the Testimonial for the professorship of natural history at the University of Toronto. By 1854 they were intimate friends, with Darwin often seeking Huxley's advice on zoological questions while preparing the text of Origin. Like Hooker and Lyell, Huxley was at first sceptical of the theory of natural selection when Darwin described it to him. Upon the publication of Origin, however, he was persuaded that natural selection was the most probable hypothesis for an evolutionary mechanism, but for him it remained a hypothesis while experimental proof was lacking. Nevertheless, Huxley wrote a number of reviews defending the book and pleading for Darwin's work to be judged solely on scientific grounds. As controversy over Origin grew, Huxley became the principal defender of the theory, a role which earned him the name "Darwin's bulldog". Huxley revelled in polemical disputes, and those waged against Owen, Bishop Wilberforce, and Mivart were typical of his pugnacious, witty manner.

While Darwin had avoided a discussion of man's relationship to his evolutionary theory in Origin, Huxley tackled the question fearlessly. His study,

Evidence as to Man's Place in Nature (1863) investigated man in zoological terms, and demonstrated that the differences between man and the apes were less than those between the apes and the lower primates. Huxley is remembered principally for his aggressive defence of Darwinism. Yet his independent scientific work in invertebrate and vertebrate zoology and in paleontology, and his activity as an educator and public figure would have been sufficient to earn him a foremost place in nineteenth century intellectual history.

Herbert Spencer (1820-1905) wrote on a wide range of philosophical, scientific and political subjects, though his formal training in these disciplines was, at most, slight. While dabbling in biology, he came across Karl Ernst von Baer's idea of progressive differentiation and by grafting this idea on to the Lamarckian notion of adaptation, Spencer formed his own principle of evolution, which he advanced in an abstract and speculative essay, "Development hypothesis", published in The Leader in 1852. In the same year another of his essays, "Theory of population" in the Westminster Review proposed that the pressure of population was the agent of progress. It was to Spencer's everlasting regret that he did not connect the theories expressed in these two essays, for had he done so, he might have arrived at a theory of natural selection.

Spencer's dilettantism and eclecticism annoyed many of his contemporaries, including Darwin. Yet he is remembered as a popularizer of both the concept and the word "evolution", and for coining the phrase "survival of the fittest". Spencer also set down the basic principles of evolutionary ethics, in which moral conduct was to be defined as that which contributed to man's better adaptation to his environment and to his higher evolution.

St. George Jackson Mivart (1827-1900) regarded himself as one of the earliest supporters of the theory of natural selection, but gradually he became disenchanted, and by 1871 was in complete disagreement. Mivart's repudiation is found principally in his Genesis of Species (1871), which, as Darwin admitted, was a formidable piece

of scientific criticism; indeed, it was the most trenchant criticism ever levelled against natural selection. Mivart's work accumulated all the previous criticism and cited contradictory opinions expressed by Darwin's supporters and even by Darwin himself. However, the scientific argument was marred by personal disparagement. In Genesis and elsewhere, Mivart, a staunch Catholic, advanced his own evolutionary theory. He held that an "internal innate force" was the main agent in evolution, a force that was attributable to the direct intervening hand of God. While accepting natural selection as a partial explanation of the corporeal evolution of man, Mivart insisted that divine intervention was responsible for the formation of man's mental powers and his soul.

Mivart's critique provoked Darwin into one of his few direct involvements in controversy. At his own expense he published a paper by the American naturalist Chauncey Wright, which exposed Mivart's deliberate misrepresentation and distortion of facts. Furthermore, Darwin added a new chapter to the 6th edition of Origin which took account of Mivart's criticism. The controversy continued until Darwin finally withdrew from active participation, leaving Huxley and Wright to continue the dispute with Mivart. In his autobiography Darwin was able to forgive all his critics with the exception of Mivart whom he condemned as a "religious bigot".

In 1876 Mivart was awarded an honorary doctorate by Pope Pius IX, probably in recognition of his efforts to reconcile evolutionary theory and Catholic dogma. However, he was subsequently excommunicated from the church for his rejection of papal infallibility.

Darwin's champion in the United States was Asa Gray (1810-1888), who succeeded in having an authorized American edition of Origin published, and in ensuring that Darwin's theories were given a fair hearing among American scientists. Gray defended Darwin's theory against its detractors in a series of sympathetic yet critical reviews that earned praise from Darwin himself. Gray's reviews,

which appeared between 1860 and 1863 in several American periodicals and papers of learned societies, were later collected and incorporated in his book Darwiniana (1876).

Gray was one of the first to emphasise the religious significance of Darwin's theory. He argued convincingly that natural selection was not inconsistent with natural theology, and defended this conviction against the militant anti-Darwinian theologians on the one hand, and against the positivist and materialist pro-Darwinists on the other.

The immediate and favourable reception of Darwinism in Germany was due largely to the enthusiastic efforts of Fritz Müller (1822-1897), August Weismann (1834-1914) and Ernst Haeckel (1834-1919). Origin had a profound influence on each of these scientists and determined the future direction of their work; yet none was content to accept Darwin's theory as it was, and Weismann and Haeckel in particular sought to carry the theory beyond its original application.

Müller's Für Darwin (1864) was crucial in gaining support for Darwin's theory in Germany. At the same time it was a major contribution to evolutionary biology at a critical stage in its infancy. Müller's biological work encompassed marine zoology, anatomy, entomology and botany, and he made an important contribution to the theory of mimicry. In Brazil Müller applied Darwin's theory to crustacea, proving to his own satisfaction that natural selection provided the key to the developmental history of these organisms. Müller corresponded for many years with Darwin, who financed the English translation of Für Darwin in 1869 (translated as Facts and Arguments for Darwin).

The principal contributions of the zoologist August Weismann to the Darwinian theory were his Über die Berechtigung der Darwin'schen Theorie (1868), and Studien Zur Descendenztheorie (1875-76), the English translation of which includes a preface by Darwin. Sceptical of Darwin's hypothesis of pangenesis, Weismann developed his own theory of heredity. Distinguishing germ cells from somatic cells, he discovered that only germ cells were involved in reproduction and were inherited.

Somatic cells could be modified by environment, but unless the modifications affected the germ cells, they were not passed on. Weismann's work in this area led to great advances in the field of genetics.

Darwin's theory provided Ernst Haeckel with a firm foundation for his work in marine zoology. But going beyond an interpretation of the theory and the provision of additional evidence in support of it, Haeckel saw as his purpose the complete reform of biology and the development of a scientific world-view based on evolutionary principles. His Generalle Morphologie der Organismen (1866) contained philosophical, political and religious questions in which Haeckel advocated sometimes dubious conceptions drawn from evolutionary theory. Also in this work, Haeckel drew genealogical family trees for all manner of organisms, including man. His study on the origin of man was based on comparative anatomy and followed the work of Huxley, Lyell and others in this field. Haeckel's historical importance lies in his suggestions which stimulated further work. His zealous advocacy of Darwin's ideas contributed to a breakthrough of evolutionary thought in the development of biological theories.

The work of these, and other scientists, firmly established the theory of natural selection as a major component of biological investigation. The refinement and application of the principles advocated by Darwin continue to the present, as do many of the controversies first discussed in the late nineteenth century "Age of Darwin".